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# Cecil Exercise

## Instructor's Copy

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University of Kentucky, Lexington, Kentucky

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This latent image exercise was developed and field tested under U. S. Bureau of Mines research contract no. HO348040. Information about the design and characteristics of the exercise and the field test results are available in the project technical reports filed with the Bureau of Mines Research Center in Pittsburgh, PA. This is one of more than 30 exercises designed for use in annual refresher training to teach and test critical skills for coping with mine emergency situations. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies or recommendations of the Interior Department's Bureau of Mines or the U. S. Government.



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Appendices

- Appendix A: Problem booklet (duplicate this copy for use in class)
- Appendix B: Answer sheet blank (print the latent image answers on this)
- Appendix C: Latent image answers (print these on the answer sheet)

## Introduction

This document contains most of the materials needed to use the exercise. The main part of the document is the instructor's copy. It tells how to use the exercise, presents the objectives, the master answer sheet, the scoring key, and discussion notes to be used following the exercise. The next section summarizes results from field tests of the exercise, and reports the miners' evaluation of the activity. The last part of this document is three appendices. Appendix A is the exercise problem booklet. This booklet can be duplicated locally. The booklets are reusable. One is needed for every person in the classroom. Appendix B is the answer sheet and the trainee's questionnaire. Copies of this answer sheet must have the latent image (invisible) ink answers that appear in Appendix C printed on them.[1] Answer sheets are consumable. One is needed for each person or each small group of persons who work the exercise.

## Exercise Summary

Read this section first. It determines if the exercise is appropriate for your classes. If you choose to use the exercise, examine the table of contents and review the remainder of this document.

Type: Latent image

Length: Ten questions (20 minutes administration plus 30 minutes for discussion)

Skills:
- Escape from smoke
- Basic ventilation procedures
- Selecting good evacuation routes and procedures
- Fire Fighting
- First aid for a blow to the head

Location: Underground

Problem: Big Tim and you are working on a supersection. You are in #1 entry (return air course) at the face replacing bits on a continuous miner when heavy smoke comes down on you from somewhere on the section. You have your filter self-rescuer. Tim left his in #8 entry. You have to find a way to help Tim, plan a good route to travel through the smoke to warn others and get help, and help locate and fight the fire.

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[1] You can do this yourself if you have the proper equipment, or you may wish to purchase copies of preprinted latent image answer sheets from the University of Kentucky, IMMR, 234 Mining and Minerals Resources Building, Lexington, KY 40506, (606) 257-8636, or the National Mine Health and Safety Academy, P.O. Box 1166, Beckley, WV 25802, (304) 255-0451.

## HOW TO USE THIS EXERCISE

1. Look at the performance objectives. Decide if the exercise is relevant for your annual refresher class.

2. Work through the exercise with the special pen and score your responses.

3. Read the master answer sheet for the exercise. Look at all the answers.

4. Read the "Instructor's Discussion Notes" for the exercise.

5. Become thoroughly familiar with the problem so that you can present it to your class without reading it. Put the maps or illustrations on an overhead projector so you can use these to help explain the problem.

6. When you present the exercise to the class:

   - Explain that the answers from class members will be used to improve the exercise in the future.

   - Give each person an exercise booklet, an answer sheet and a pen.

   - Demonstrate how to select and mark answers using the special pen.

   - Go over the instructions for doing the exercise with the whole group.

   - Explain the problem making sure everyone understands the problem situation.

   - Have the class members work the exercise.

   - When the class members finish, have them figure up their score using the instructions at the end of the exercise.

   - When everyone has finished, discuss the exercise. Let class members discuss the merits of each answer. Add your own ideas. Then have each person fill out the Trainee's Questionnaire attached to the answer sheet.

   - After class look over the completed trainee questionnaires and the answer sheets. This information may provide ideas for improving the exercise for future classes. Write out your ideas for improving the exercise and send them to the following address.

IMMR/BRASH
201 Porter Building, University of Kentucky
Lexington, Kentucky, 40506-0205 ph. (606) 257-3796

## Performance Objectives for Cecil Exercise

| Objective number | Capability verb(s) | Description of required performance and conditions under which it is to occur |
|---|---|---|
| 1 MG* | Recall<br>Recognize | Origins, probable concentrations, and physiological effects of toxic gases and smoke resulting from an unknown source |
| 2 MG/EE | Assess<br>Plan | Course of action for rapid evacuation from the face through heavy smoke |
| 3 MG/EE | Originate<br>Plan<br>Execute | Method of temporarily protecting a co-worker without an FSR or SCSR from heavy smoke by using available materials |
| 4 MG | Recall | Physical characteristics of hot air and smoke, especially their relative density |
| 5 EE | Identify<br>Discriminate<br>Plan | Escape routes through smoke to a safer area, given a map of a mine section |
| 6 EE/FA | Evaluate<br>Select | Critical actions to minimize the risk of further injury to a roof fall victim and co-workers |
| 7 EE/FA | Recall<br>Identify<br>Discriminate<br>Plan<br>Execute | Proper steps and sequence for reporting a fire, accounting for all miners, effectively fighting the fire with available means, and treating an injury victim |
| 8 EE | Identify<br>Discriminate | Probable factors contributing to a shuttle car cable fire and subsequent ignition of combustible materials and coal |
| 9 MG | Recall<br>Discriminate | Physical and chemical characteristics and physiological effects of carbon monoxide |

*Skill and knowledge domain abbreviations:
MG = mine gases
EE = emergency evacuation and escape
FA = first aid

## Master Answer Sheet for Cecil Exercise

Use this answer sheet to mark your selections. Rub the special pen gently and smoothly between the brackets. Don't scrub the pen or the message may blur. Be sure to color in the entire message once you make a selection. Otherwise you may not get the information you need.

**Question A** (Choose only ONE unless directed to "Try again!")

1. [ You shouldn't do this unless you plan to put it on now. Try again! ]

2. [ He's probably down at the feeder. You need to act now. Try again! ]

3. [ Correct! Carbon monoxide may be present. Do next question. ]

4. [ This is very dangerous! You and Big Tim may die. Try again! ]

**Question B** (Choose only ONE unless directed to "Try again!")

5. [ Correct! A "snap" decision could prove fatal to both of you. You are not yet in ]
   [ smoke. Do next question. ]

6. [ This would be difficult to do, and you would likely become separated in the ]
   [ smoke. Try again! ]

7. [ There is a more critical first step. Try again! ]

8. [ Although "misery loves company," it is important that at least one of you is ]
   [ protected from carbon monoxide. Try again! ]

9. [ Should it be necessary for someone to get through the smoke quickly, it ]
   [ should be you rather than Tim. Try again! ]

**Question C** (Choose only ONE unless directed to "Try again!")

10. [ The effects of carbon monoxide do not depend on physical condition. Try ]
    [ again! ]

11. [ This will not protect him from carbon monoxide. You still don't know the ]
    [ source or extent of the smoke. Try again! ]

12. [ Smoke is slowly drifting in toward the face. Tim would soon be overcome. Try ]
    [ again! ]

**Question C** (continued)

13. [ Correct! This is only a short-term solution, but should protect him until help ]
[ can arrive. Do next question. ]

**Question D** (Select as MANY as you think are correct.)

14. [ Correct! Hot air and smoke tend to rise. Moving close to the face will buy ]
[ more time. He should also try to remain calm. ]

15. [ Hot air and smoke will be thickest near the roof. ]

16. [ This will not make a difference. ]

17. [ Correct! This will provide a second "barricade" and double protection. ]

18. [ Absolutely not! This would cause leakage and place Tim in danger. ]

19. [ Correct! The water will help seal the brattice material and provide more ]
[ protection from smoke and CO. ]

**Question E** (Choose only ONE unless directed to "Try again!")

20. [ You are in heavy, black smoke and can't see. Your FSR becomes very hot. ]
[ You soon get disoriented. Try again! ]

21. [ You are in heavy, black smoke and can't see. Your FSR becomes very hot. ]
[ You soon get disoriented. Try again! ]
[ ]

22. [ You are in heavy, black smoke and can't see. Your FSR becomes very hot. ]
[ You soon get disoriented. Try again! ]

23. [ Correct! By running your left hand around pillar a, you quickly get into fresh ]
[ air through the check curtain in the crosscut between #1 and #2. Do next ]
[ question. ]

**Question F** (Choose only ONE unless directed to "Try again!")

24. [ The fire may soon be out of control, but there is still a more critical first step. ]
[ Try again! ]

25. [ Matt may need his FSR. But there is a more critical first step. Try again! ]

26. [ There is a more critical first step. Try again! ]

**Question F** (continued)

27. [ Correct! You yell to the face boss and two other miners near the stuck shuttle ]
[ car. Do next question. ]

28. [ It would be dangerous to go back for Tim now. There is a more critical first ]
[ step. Try again! ]

**Question G** (Select as MANY as you think are correct.)

29. [ Correct! The fire looks small. You have an adequate number of extinguishers ]
[ and a good supply of rock dust. ]

30. [ Correct! The faceboss says that only Tim is missing. Everyone else is ]
[ accounted for and now knows about the fire. ]

31. [ Correct! Management can help locate additional fire fighting supplies and ]
[ may want to clear all miners not fighting the fire from the mine. ]

32. [ SCSRs are not intended for rescue. You should <u>not</u> search for Tim until the ]
[ fire is extinguished and the smoke has cleared. ]

33. [ Correct ! Only a quick survey of his condition was done earlier. He can now ]
[ be treated for his injuries at a safe distance from the fire. ]

34. [ Correct! This probably was done by Matt before repairs were started, but it's a ]
[ good idea to check anyway. ]

35. [ Correct! While the others are fighting the fire with rock dust and fire ]
[ extinguishers, preparations to use water should be made. The fire may be ]
[ larger than first suspected. ]

36. [ This would be difficult to do in smoke. A mistake could interfere with keeping ]
[ those fighting the fire in fresh air. ]

37. [ This would endanger Tim and the mine. The miners and materials needed to ]
[ fight the fire are available. ]

38. [ Correct! These may be needed to complete the job and to put out the oil fire. ]

**Question H** (Select as MANY as you think are correct.)

39. [ This procedure is acceptable, providing the proper precautions are taken. ]

40. [ Correct! Matt should have sounded the top before beginning repairs and any ]
[ loose rock should have been either taken down or bolted up. ]

**Question H** (continued)

41. [ Correct! Matt should have put rock dust on the oil or pulled more cable from the reel and changed position before using the torch. ]

42. [ Correct! This added fuel to the fire. ]

43. [ All trailing cables are made from flame-retardant material. ]

**Question I** (Select as MANY as you think are correct.)

44. [ Correct! Blood has a 300 times greater preference for CO than for oxygen. ]

45. [ CO is odorless, colorless, and tasteless. ]

46. [ CO is almost the same density as air. Generally, it rises toward the top with hot air and smoke. ]

47. [ Correct, but only in concentrations between 12.5 and 75%. ]

48. [ Correct! ]

49. [ Unconsciousness will occur in less than 30 minutes and death in less than an hour in only 0.16% CO. ]

50. [ CO is <u>extremely</u> toxic, even in very low concentrations. ]

51. [ Correct! But no matter what it's called, it's still very dangerous, even in very low concentrations. ]

52. [ Any irritation that comes from a fire is from smoke particles and not CO. ]

**Question J**

_____

_____

_____

_____

END OF PROBLEM

**Finding your score**

Number of "Correct" answers you colored in = (1)_____

30 minus number of incorrect answers you colored in = (2)_____

Add blanks one and two to get your total score = (3)_____

Highest possible score = 52

Lowest possible score = 0

## TRAINEE'S QUESTIONNAIRE

1) name of exercise _____Cecil_____

2) your age _____ 3) your sex _____ M _____ F 4) years underground coal miner _____

5) your job title _____

Check all the areas in which you have special training, certification, and/or that you routinely perform.

| | | Special Training | Certification | Routinely Perform |
|---|---|---|---|---|
| 6) | Mine Foreman | _____ | _____ | _____ |
| 7) | Mine Safety Committee | _____ | _____ | _____ |
| 8) | Mine rescue | _____ | _____ | _____ |
| 9) | CPR | _____ | _____ | _____ |
| 10) | Advanced first aid | _____ | _____ | _____ |
| 11) | EMT | _____ | _____ | _____ |
| 12) | Advanced life support | _____ | _____ | _____ |
| 13) | Other (describe) _____ | _____ | _____ | _____ |

Think about the exercise you just finished. Circle the number which tells how much you agree or disagree with the following statements.

| | | Definitely Yes | | | Definitely No |
|---|---|---|---|---|---|
| 14) | This problem could happen in real life. | 4 | 3 | 2 | 1 |
| 15) | This exercise will help me remember something important if I am ever in a similar situation. | 4 | 3 | 2 | 1 |
| 16) | I learned something new from the exercise. | 4 | 3 | 2 | 1 |
| 17) | The exercise took too long to complete. | 4 | 3 | 2 | 1 |
| 18) | I liked working the exercise. | 4 | 3 | 2 | 1 |
| 19) | The instructor's directions were clear. | 4 | 3 | 2 | 1 |
| 20) | The written directions in the exercise were easy to understand. | 4 | 3 | 2 | 1 |
| 21) | The diagrams, charts, and pictures were easy to understand. | 4 | 3 | 2 | 1 |
| 22) | The scoring procedures were easy to understand. | 4 | 3 | 2 | 1 |
| 23) | The exercise was easy to read. | 4 | 3 | 2 | 1 |

If you have anything more to say about the exercise, please write on the back of this page. Thank you.

## Instructor's Discussion Notes for Cecil Exercise

Use the information presented here and on the master answer sheet, your own ideas and experience, and that of the miners in your class to discuss the exercise after it is completed. Group discussion can strengthen knowledge and skills, correct errors, and relate the exercise content to the experiences of the miners. After they have worked the exercise, miners enjoy discussing the problem. They also frequently think of better ways to respond to a problem than those listed among the answers. The purpose of the exercise is to help miners think about and remember basic knowledge and skills they may someday need to deal with a mine emergency. The discussion following the exercise can contribute to this goal and tailor the exercise content to the needs of the group you are training.

It is helpful to show overhead transparencies of the answers on the master answer sheet during the discussion, while the miners look at their problem booklets. This allows you to lead the group through the exercise and to discuss all the answers to each question. Most of the information about why particular answers are correct or incorrect is given on the master answer sheet.

The following notes provide additional information for you to discuss with your class. Read through and think about the notes before the class. Don't read the notes to the class members. This would be boring and ineffective. Rather, incorporate the ideas you find here with your own ideas and make these points at the appropriate place in the discussion of the exercise.

Question A - The correct answer is 3. The most important thing to do at this time is to protect yourself from possible CO poisoning. A filter self-rescuer (FSR) should not be taken off your belt until its ready to be used, which should be at the first sign of smoke. A miner in this situation should not wait for instructions, nor should he attempt escape without respiratory protection.

Question B - The correct answer is 5. Reaction to all emergencies requires careful deliberation, especially when emergency evacuation and escape is complicated by such conditions or circumstances as: blocked passages, unavailable or inoperative personal protective devices, unavailable or defective first aid supplies and materials, and the movement of physically or emotionally impaired victims. Sharing FSRs in a CO contaminated atmosphere is ineffective. The source and extent of the smoke is unknown at this time, so maximum protection is advisable. Going across the section in heavy, black smoke is dangerous because of the possibility of oxygen deficient air, for which the FSR is of no value. Further, it would be difficult, if not impossible, to see well enough to travel. Getting lost and disoriented is likely. Offering your FSR to a co-worker is a noble gesture, but if someone must go for help, it should be the more agile of the two. Also, the life of a FSR in a CO rich atmosphere is directly proportional to the air exchange volume of the wearer, which would be lower for the more physically fit miner. Answer 8 might comfort Big Tim, but it could result in the death of both miners. There have been many instances of CO deaths in mine fires where the seals on the victims' FSR units were never broken. Whenever smoke is present, CO should

be suspected!

Question C - The correct answer is 13. If this were a gassy mine, this might not be the best action. It is clear however, that immediate escape for Tim involves travel through smoke without a FSR and should not be attempted. A seal across the entry should direct enough of the smoke away from the face area of the #1 entry to keep the CO at a relative low level until help can arrive. Again, the miner should not offer his FSR to Tim for the same reason discussed in Question B. Although a damp rag can protect the eyes, nose, and throat from some of the irritants in heavy smoke, it offers no protection from CO. To have Tim remain in the #1 face without the curtain in place could prove fatal. The smoke may soon drift into all available space.

Question D - The correct answers are 14, 17, and 19. The density of CO relative to air (1.00) is 0.9672. Thus, for all practical purposes, the density of air and CO are the same. When the air is moving, CO is likely to mix with it and not rise above it. Smoke and hot air from a fire (often CO rich) however, is much less dense than cool air, and therefore rises. The air along the bottom tends to be cleaner and cooler. Tim should position himself near the mine floor as far away from the smoke cloud as possible(14). He can provide added protection from smoke and CO by placing a second line brattice across the entry inby the first one (17). Wetting the brattices with the wash down hose is an excellent idea. The water will seal the pores in the brattice material and make the seals much more smoke resistant. It is doubtful that anyone will select 18, but how many in your class would probably do this if confronted with this situation? Anxiety and curiosity invite this action, as miners would look for cap lamps of rescuers and the status of the smoke cloud.

Question E - The correct answer is 23. This route minimizes the CO exposure. Route A takes you directly toward the fire, where smoke would be the heaviest. Not only will the CO concentration be highest with the choice of this path, but there is the risk of oxygen deficiency. It would also be very difficult to travel without becoming disoriented. Route B also takes you into heavy smoke, through which travel would be difficult. There is also still the risk of oxygen deficiency. There is no good reason for selecting Route C. This would prolong exposure to what is almost assuredly a CO rich and oxygen deficient atmosphere. All routes except D are too long and roundabout or require traveling in heavy smoke. Route D helps the miner find his way quickly to neutral air, which is likely to be smoke free (although by no means certain). The straight path across the last open crosscut just outside the #1 face will put the miner in contact with pillar a. (See Figure 2.) He or she can then follow the ribline by keeping his left hand in contact with the pillar. This question provides you with a good opportunity to discuss the capabilities, limitations, and use of FSRs.

Question F - The correct answer is 27. Once the fire is discovered, help should be obtained to fight it. Miners should be aware of the likely location of others in their crew, should rapid communication be required. To randomly hunt for crew members in a large area, such as one created by a supersection, wastes valuable time. By remembering the location of the shuttle car stuck by the feeder, the miner in this question was able to quickly find help. To fight the fire alone is ill-advised. Should a

single miner fighting a fire be overcome or be unable to extinguish it, others could be injured. Once the fire is discovered, it should be reported immediately. To return for Tim would place everyone on the section in danger and could allow the fire to grow. A quick primary survey of Matt's condition revealed no life threatening injuries. He is conscious and able to talk. To treat him while the fire is growing would endanger everyone on the section.

Question G - The correct answers are 29, 30, 31, 33, 34, 35, and 38. Before any further action is taken, all miners should be accounted for and removed from danger (30). The fire is relatively small, but can soon become a major threat. Enough miners and equipment are available to fight the fire and this action should be given priority (29). It is also important to report the fire to management right away so they can call a mine rescue team to stand by and notify the proper state and federal authorities (31). While these tasks are going on, Matt can be given first-aid treatment in a safe place (33). (You might discuss how Matt should have been treated when discovered if: 1) his injuries were more severe, 2) his clothing were on fire, or 3) he had a suspected spinal injury.) In this problem, the availability of rock dust, fire extinguishers, and several miners make fighting the fire with these class B agents the fastest and best option. It takes much longer to disconnect and move a high pressure water hose. However, it is wise to send two miners to begin preparing a water line to fight the fire, should that become necessary (35). Search and rescue are functions of mine rescue and should not be attempted without proper equipment. FSRs and SCSRs should not be used for this purpose (32). If the fire is fought promptly and well, and if Tim properly protects himself from the smoke, he will be O. K. and can be rescued by miners traveling in fresh air.

The power to the shuttle car with the damaged cable is probably off. Otherwise Matt should not have been splicing the cable (30 CFR 75.511). But there are plenty of miners on the section. It would be a good idea to send one of them to make sure the power was off (34). Short circuiting the air would not be a good idea (36). The ventilation should not be disturbed. In addition to violating 30 CFR 75.322, this action could confuse others on the section who might already be attempting to escape. Also, to successfully short-circuit the air would require several changes in the face ventilation, as shown on Figure 4 on the next page. Such changes would be difficult to make under stressful conditions and in heavy smoke. To make a mistake could contaminate all air on the section and interfere with fighting the fire. Such ventilation changes would also waste precious time during which the fire might get out of control. Regulating the air by hanging a curtain across #1 (return) could slow the fire's spread, but most experts agree that this should not be tried unless the fire starts getting out of control. The fire, as described, is still controllable. It would be improper and unethical for all the miners to leave the section at this time (37). The situation is dangerous but not yet life threating. You might discuss how the answer to this question can change if the mine were gassy or if an explosion occurred. It would be a good idea to send a miner for more rock dust and fire extinguishers (38). These may be needed later.

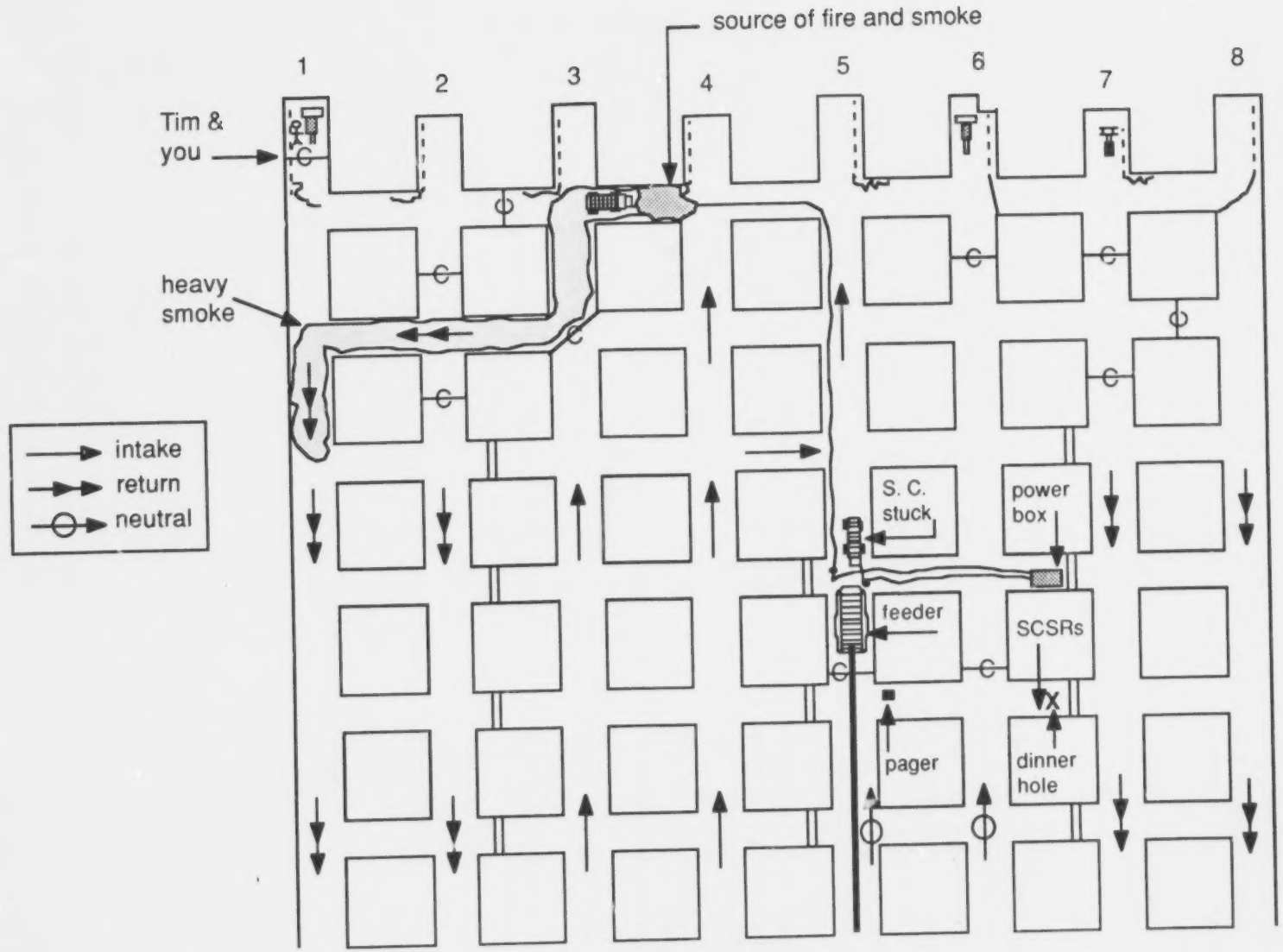


Figure 4: Ventilation changes required to short-circuit the smoke to help protect Tim

Question H - The correct answers are 40, 41, and 42. Repairmen should be reminded to pay attention to roof conditions where they are required to work (40) and should practice good housekeeping, especially when a heat source is to be used (41 and 42). If hot splices are preferred over cold ones (tape, tape and sleeve, and expanded sleeve), special precautions should be taken to prevent fire and explosion (39). If open flames are necessary for repair work in or inby the last open crosscut, a methane test should be made and fire fighting equipment should be brought to the work site before repairs are began. One manufacturer of splice kits supplies flameless chemical sources of heat to shrink and seal the splice boot. All trailing cables are flame-retardant (43) in accordance with 30 CFR 75.600.

Question I - The correct answers are 44, 47, 48, and 51. Although explosive at high concentrations, the property that makes CO so dangerous is it's extreme toxicity. It has no distinguishing physical properties, thus making it difficult to detect. "White damp" is about the same density as air, and is a natural product of combustion. CO acts as an asphyxiant by displacing the oxygen normally carried by the hemoglobin of the blood. The affinity of the blood for CO is about 300 times that for oxygen. At a concentration as low as 0.10%, loss of some mental function can occur within 45 minutes; collapse, unconsciousness, and coma can occur within 1 hour; and death can occur only 30 minutes later. By comparison, you might point out that 0.1% concentration is 50 times less than the concentration of the lower explosive limit for methane (5%). Figure 5 on the next page gives values of CO that are disabling at various concentrations and times.

Question J - Ask your class members if they found any other errors of judgment, or violations of rules and procedures other than:

- Big Tim leaving his FSR on a piece of equipment far away
- An accumulation of loose coal and dust in the last open crosscut
- Matts failure to inspect the top before he made the splice
- Failure to clean up the oil spill near the shuttle car with the damaged cable

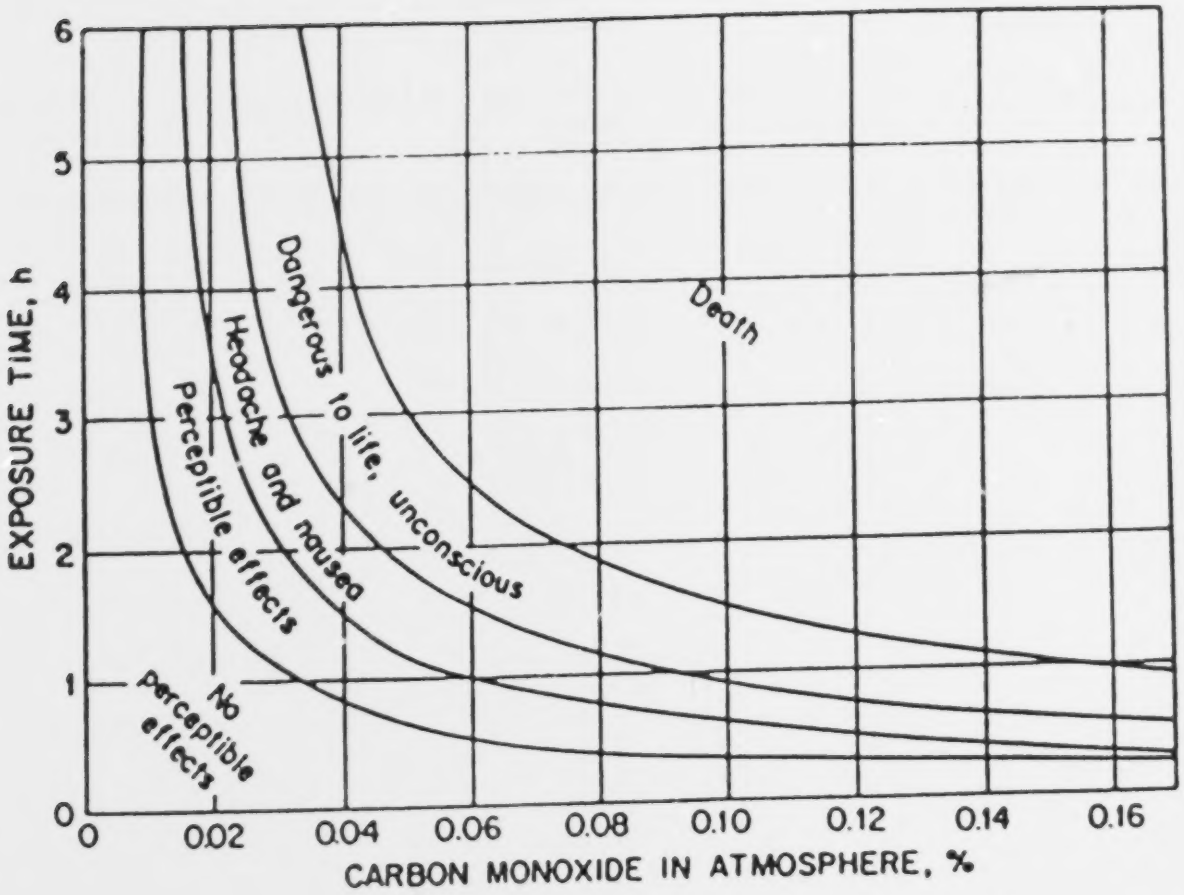


Figure 5: Toxicity of carbon monoxide as a function of concentration and time. (Hartman, Mutmansky, & Wang 1982.)

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## Scoring Key for Cecil Exercise

**Question A**

1. __W__
2. __W__
3. __R__
4. __W__

**Question B**

5. __R__
6. __W__
7. __W__
8. __W__
9. __W__

**Question C**

10. __W__
11. __W__
12. __W__
13. __R__

**Question D**

14. __R__
15. __W__
16. __W__
17. __R__
18. __W__

**Question D** (con't)

19. __R__

**Question E**

20. __W__
21. __W__
22. __W__
23. __R__

**Question F**

24. __W__
25. __W__
26. __W__
27. __R__
28. __W__

**Question G**

29. __R__
30. __R__
31. __R__
32. __W__
33. __R__
34. __R__
35. __R__
36. __W__

**Question G** (con't)

37. __W__
38. __R__

**Question H**

39. __W__
40. __R__
41. __R__
42. __R__
43. __W__

**Question I**

44. __R__
45. __W__
46. __W__
47. __R__
48. __R__
49. __W__
50. __W__
51. __R__
52. __W__

## Summary of Field Test Results

The Cecil Exercise (CEC) underwent three rounds of field testing, including authentication and field tests one and two. The authentication consisted of a small initial field test that produced too little data for meaningful statistical summaries, but many comments, criticism, and suggestions that were used to revise and improve the exercise before the first formal field test. The formal field tests involved carefully controlled administration of the revised exercise to groups of miners at multiple sites. Each field test resulted in data used to revise and improve the exercise prior to the next field test of the new version. Tables that summarize the results of the field tests for both CEC1 and CEC2 are attached. The version of the exercise included in this document includes all of the cumulative revisions made as a result of the three rounds of field tests.

CEC1 was tested with 63 miners, in 2 classes, at 1 site. CEC2 was field tested with 145 miners, in 7 classes, at 2 sites. One set of tables is attached for the field test results of CEC1 and another similar set for CEC2. Each set of tables is divided into two parts. The first part describes the people who participated in the field test and their evaluation of the exercise. The second part describes the measurement properties of the exercise.

Sample characteristics and miners' evaluations

Tables 1 through 3 describe demographic characteristics of the sample. Table 4 indicates the number of persons in the sample who reported either some training, special certification, and/or routine performance of the eight areas listed as rows in the table. Inspection of these three tables quickly reveals the numbers and types of persons involved in the field test of the exercise.

Table 5 reports the miners' judgment of the exercise quality and worth. Each person was asked to rate the value of the exercise on each of eleven qualities. By checking a number on a scale, miners indicated to what extent the exercise displayed each quality. Inspection of the values in Table 5 reveals the percentage of miners who reported that the exercise 1) was realistic, 2) helped them to remember important things, 3) helped them learn something new, 4) was too long, 5) was enjoyable, 6) should be used in other classes, 7) instructor's directions were clear, 8) written directions were clear, 9) illustrations and maps were clear, 10) scoring procedures were easy to understand, and 11) was easy to read.

Psychometric properties

The next set of tables describe the psychometric (mental performance measurement) properties of the exercise. Table 6 presents summary data for each of the exercise questions, including the minimum, maximum, median, and mean question scores observed in the sample; the standard deviation and skewness of each question score; the squared correlation coefficient of each individual question score with the exercise total score; and the estimated reliability of the total exercise score if that particular

question were dropped from the test. The last line in Table 6 reports the same information for the total exercise score. This is obtained by summing question scores across the whole exercise. Each question is weighted such that a perfect score on each question sums to 100 for the exercise total score. Inspection of the table quickly presents the basic performance data for the sample.

The weighting of each question score to produce a total score of 100 is designed to allow comparison of the difficulty of different versions of the same exercise, or different exercises, even though these often have different numbers of questions. The total score of 100 is also a common convention for reporting test scores.

Table 7 reports the number of answers (options) to questions that discriminated properly between persons with high scores on the test and those persons with low scores. Tests that have multiple choice answers to questions must include some incorrect and some correct answers. The person who takes the test must choose among correct and incorrect answers (distractors) to each question. Persons who get a high total score on the test know more about the test content than persons who get low scores. Therefore, when data are aggregated from the whole sample of persons who took the test, wrong answers (distractors) to each question on the test should be significantly negatively correlated with the overall test score, and correct answers to questions should be significantly positively correlated with the exercise total score. When correct answers and wrong answers (distractors) behave this way, the answer (whether correct or incorrect) is said to positively discriminate between persons who know much about the content and those who know little. However, when persons who get high scores on the total test tend to pick wrong answers (distractors) more frequently than persons who get low scores, the answer is said to reverse or negatively discriminate. The opposite case is also true. That is, when persons who get low scores on the total test score tend to pick a right answer to a question more frequently than persons who had high total test scores, that answer is also said to reverse or negatively discriminate. The discrimination values are used to identify and correct problems in the answers for questions. To be valid, the method requires an adequate sample of persons who exhibit a wide range of variability in their total test scores.

Table 7 reports the frequency with which answers to questions behaved in this desirable way. The table tells the percentage of answers to questions on the test that discriminated positively, negatively, or not at all among the ability levels represented in the field test sample.

Another way to look at the discrimination capability of a test is to divide the sample into groups of persons with greater or lesser levels of expertise. Table 8 reports the degree to which the exercise total score discriminated between persons in the sample with different levels of self-reported expertise. For example, Table 8 shows that the CEC1 exercise did discriminate significantly between those persons who said they had some mine rescue or other technical mining training and those who did not report such training. The means and standard deviations for these two groups are given as well as the F ratio and the p value.

Finally, the last table is another discrimination analysis for the total exercise score, this time between the self-reported major job categories represented in the sample. The category "miners" includes all working miners that are not supervisors, surveyors, engineers, etc. The "maintenance/technical" category includes all inspectors, engineers, surveyors, electricians, mechanics, and other technical and maintenance personnel who work in the mines and typically have special skills, and who move from section to section as they complete their work. The "supervisory/management" category includes all managers from the mine section foreman on up. The "other" category includes all other persons such as preparation plant and surface mine workers, personnel, office staff, and others who are not miners but who often participate in annual refresher training classes.

The number of miners reported in the tables vary. This is because not all miners answered all of the questions on the trainee questionnaire. Also, some of the data received from the field tests reflect individual performances, while other data reflect small group performance. Instructors often had the miners work the exericse in small groups. This is a good instructional procedure that miners enjoy. However, the psychometric studies require individual exercise administration in order to carry out the discrimination analyses. Therefore, tables 1 through 5 report the actual or valid percent of persons who responded to specific items on the trainee questionnaire. The remainder of the psychometric tables report data for the number of persons who properly completed the exercise individually.

Characteristics of the CEC exercise

The exercise is sound. It was field tested on a sufficiently broad and varied sample to produce robust empirical data. Miners who completed the exercise judged it favorably. The exercise does discriminate between those with advanced and basic levels of training in mine rescue or other technical areas of mining. The mean score on CEC1 was 71.8 with a standard deviation of 9.62. For CEC2 the comparable values were 80.1 and 10.27. Although the exercise is moderately easy for most miners, a number of miners make errors in critical skills that should be learned to perfection. Miners and trainers report the exercise is useful in teaching and reinforcing these critical skills.

## Characteristics of the field test sample for CEC1 Exercise

( 1 site, 2 classes, n = 63 )

**Table 1**: Age and experience of miners (years)

| | n | mode | mean | s.d. |
|---|---|---|---|---|
| age | 60 | 29 | 33.0 | 7.08 |
| experience | 59 | 11 | 10.2 | 6.31 |

**Table 2**: Gender distribution (%)

| | n | frequency % |
|---|---|---|
| female | 0 | 0.0 |
| male | 60 | 100.0 |

**Table 3**: Job classification

| | n | frequency % |
|---|---|---|
| miner | 29 | 53.7 |
| maintenance/technical | 18 | 33.3 |
| supervisory/management | 7 | 13.0 |
| other | 0 | 0.0 |

**Table 4**: Self-reported level of expertise (frequency %)

| category | training | certification | performance |
|---|---|---|---|
| foreman | 13.1 | 23.0 | 11.5 |
| mine safety committee | 0.0 | 0.0 | 0.0 |
| mine rescue | 6.6 | 1.6 | 0.0 |
| CPR | 9.8 | 4.9 | 0.0 |
| advanced first aid | 6.6 | 3.3 | 0.0 |
| EMT | 3.3 | 1.6 | 0.0 |
| advanced life support | 0.0 | 0.0 | 0.0 |
| other | 1.6 | 1.6 | 1.6 |

**Table 5**: Miners' rating of exercise validity, relevance, quality, and utility (frequency %)

| content | definitely yes | | | definitely no | mean | s.d. |
|---|---|---|---|---|---|---|
| | 4 | 3 | 2 | 1 | | |
| problem could happen | 85.5 | 10.9 | 0.0 | 3.6 | 3.8 | 0.63 |
| help remember important things | 64.2 | 20.8 | 13.2 | 1.9 | 3.5 | 0.80 |
| learned something new | 57.4 | 20.4 | 14.8 | 7.4 | 3.3 | 0.98 |
| exercise too long | 10.0 | 10.0 | 16.0 | 64.0 | 1.7 | 1.02 |
| liked working the exercise | 62.3 | 24.5 | 5.7 | 7.5 | 3.4 | 0.91 |
| instructor directions clear | 77.4 | 15.1 | 3.8 | 3.8 | 3.7 | 0.73 |
| written exercise directions clear | 61.1 | 25.9 | 7.4 | 5.6 | 3.4 | 0.86 |
| graphics easy to understand | 73.6 | 20.8 | 0.0 | 5.7 | 3.6 | 0.77 |
| scoring easy to understand | 59.6 | 27.7 | 8.5 | 4.3 | 3.4 | 0.83 |
| exercise easy to read | 74.5 | 15.7 | 2.0 | 7.8 | 3.6 | 0.88 |

## Psychometric properties of CEC1 exercise

(printout date 4/27/87, 1 site, 2 classes, n = 63)

**Table 6**: Question score and total score statistics

| question | minimum score* | maximum score* | median | mean | s.d. | skewness | $R^2_{QT}$ | alpha if question deleted |
|---|---|---|---|---|---|---|---|---|
| A | 0.0 | 11.1 | 11.1 | 9.5 | 2.56 | -1.92 | 0.29 | 0.39 |
| B | 2.8 | 11.1 | 8.3 | 7.9 | 2.00 | -0.32 | 0.25 | 0.34 |
| C | 0.0 | 11.1 | 11.1 | 9.4 | 2.74 | -1.74 | 0.30 | 0.36 |
| D | 0.0 | 11.1 | 11.1 | 10.2 | 2.22 | -2.68 | 0.13 | 0.38 |
| E | 0.0 | 11.1 | 11.1 | 9.0 | 3.19 | -1.42 | 0.21 | 0.36 |
| F | 0.0 | 11.1 | 5.6 | 6.1 | 3.77 | -0.31 | 0.17 | 0.44 |
| G | 2.2 | 10.0 | 5.6 | 5.9 | 1.92 | 0.20 | 0.29 | 0.37 |
| H | 2.2 | 11.1 | 6.7 | 7.2 | 2.19 | 0.02 | 0.22 | 0.33 |
| I | 1.4 | 11.1 | 6.9 | 6.7 | 1.98 | 0.07 | 0.20 | 0.36 |
| Total | 42.9 | 86.1 | 73.6 | 71.8 | 9.62 | -0.56 | (alpha = 0.43 ) | |

*The values reported are the minimum and maximum scores observed, for this sample. The lowest possible score = 0.0 and the highest possible score = 11.1. When scores are summed across questions the highest possible score = 100 and the lowest possible score = 0.

**Table 7**: Proportion of answers discriminating positively, negatively, and not at all with exercise total score ($p<.10$)

| positive | negative | no relationship |
|---|---|---|
| 31/50 (62.0%) | 0/50 (0.0%) | 19/50 (38.0%) |

**Table 8**: Discrimination between basic and advanced levels of mine rescue/technical training

| | n | mean | s.d. | F ratio | p value |
|---|---|---|---|---|---|
| basic | 43 | 70.7 | 10.25 | 2.82 | 0.099 |
| advanced | 18 | 75.2 | 6.86 | | |

Questions that discriminate significantly at $p < .10$: D, $p = .083$.

**Table 9**: Discrimination between job categories

| | n | mean | s.d. | F ratio | p value |
|---|---|---|---|---|---|
| miner | 29 | 70.0 | 9.18 | 2.23 | 0.117 |
| main/tech | 18 | 75.9 | 9.82 | | |
| super/mgt | 7 | 73.2 | 8.93 | | |
| other | 0 | | | | |

Questions that discriminate significantly at $p < .10$: I, $p = .099$.

## Characteristics of the field test sample for CEC2 Exercise

( 2 sites, 7 classes, n = 145 )

**Table 1**: Age and experience of miners (years)

| | n | mode | mean | s.d. |
|---|---|---|---|---|
| age | 142 | 30 | 32.9 | 7.22 |
| experience | 135 | 5 | 5.4 | 4.01 |

**Table 2**: Gender distribution (%)

| | n | frequency % |
|---|---|---|
| female | 1 | 0.7 |
| male | 142 | 99.3 |

**Table 3**: Job classification

| | n | frequency % |
|---|---|---|
| miner | 66 | 48.5 |
| maintenance/technical | 45 | 33.1 |
| supervisory/management | 24 | 17.6 |
| other | 1 | 0.7 |

**Table 4**: Self-reported level of expertise (frequency %)

| category | training | certification | performance |
|---|---|---|---|
| foreman | 11.9 | 31.5 | 7.7 |
| mine safety committee | 1.4 | 0.0 | 2.8 |
| mine rescue | 13.3 | 10.5 | 2.8 |
| CPR | 22.4 | 20.3 | 6.3 |
| advanced first aid | 10.5 | 7.0 | 5.6 |
| EMT | 4.9 | 4.2 | 2.8 |
| advanced life support | 1.4 | 2.1 | 2.8 |
| other | 3.5 | 7.7 | 5.6 |

**Table 5**: Miners' rating of exercise validity, relevance, quality, and utility (frequency %)

| content | definitely yes | | | definitely no | mean | s.d. |
|---|---|---|---|---|---|---|
| | 4 | 3 | 2 | 1 | | |
| problem could happen | 87.8 | 10.8 | 1 4 | 0.0 | 3.9 | 0.39 |
| help remember important things | 66.7 | 29.7 | 2.9 | 0.7 | 3.6 | 0.58 |
| learned something new | 61.2 | 34.5 | 4.3 | 0.0 | 3.6 | 0.58 |
| exercise too long | 4.4 | 7.3 | 19.7 | 68.6 | 1.5 | 0.81 |
| liked working the exercise | 71.5 | 21.2 | 2.9 | 4.4 | 3.6 | 0.75 |
| instructor's directions clear | 83.1 | 14.0 | 2.9 | 0.0 | 3.8 | 0.47 |
| written exercise directions clear | 65.2 | 30.4 | 4.3 | 0.0 | 3.6 | 0.57 |
| graphics easy to understand | 61.6 | 34.1 | 4.3 | 0.0 | 3.6 | 0.58 |
| scoring easy to understand | 60.7 | 28.1 | 8.9 | 2.2 | 3.5 | 0.75 |
| exercise easy to read | 74.5 | 23.4 | 2.2 | 0.0 | 3.7 | 0.50 |

## Psychometric properties of CEC2 exercise

(printout dat 22/87 , 2 sites, 7 classes, n = 145)

**Table 6**: Question score and total score statistics

| question | minimum score* | maximum score* | median | mean | s.d. | skewness | $R^2_{QT}$ | alpha if question deleted |
|---|---|---|---|---|---|---|---|---|
| A | 0.0 | 11.1 | 10.8 | 11.1 | 1.35 | -5.46 | 0.25 | 0.59 |
| B | 0.0 | 11.1 | 8.3 | 8.7 | 2.23 | -0.62 | 0.15 | 0.58 |
| C | 0.0 | 11.1 | 11.1 | 9.1 | 3.41 | -1.57 | 0.15 | 0.60 |
| D | 5.6 | 11.1 | 9.5 | 9.3 | 1.75 | -.536 | 0.20 | 0.59 |
| E | 0.0 | 10.1 | 11.1 | 11.1 | 2.36 | -2.64 | 0.25 | 0.57 |
| F | 0.0 | 11.1 | 8.3 | 8.1 | 3.05 | -0.68 | 0.11 | 0.61 |
| G | 2.2 | 11.1 | 7.8 | 7.7 | 2.16 | -0.57 | 0.23 | 0.62 |
| H | 0.0 | 11.1 | 8.9 | 8.4 | 2.16 | -0.57 | 0.13 | 0.62 |
| I | 3.7 | 11.1 | 7.4 | 7.7 | 1.54 | -0.09 | 0.13 | 0.61 |
| Total | 24.9 | 97.8 | 80.8 | 80.1 | 10.27 | -1.48 | (alpha = 0.65) | |

*The values reported are the minimum and maximum scores observed, for this sample. The lowest possible score = 0.0 and the highest possible score = 11.1. When scores are summed across questions the highest possible score = 100 and the lowest possible score = 0.

**Table 7**: Proportion of answers discriminating positively, negatively, and not at all with exercise total score (p<.10)

| positive | negative | no relationship |
|---|---|---|
| 45/52 (86.5%) | 0/52(0.0%) | 7/52 (13.5%) |

**Table 8**: Discrimination between basic and advanced levels of mine rescue/technical training

| | n | mean | s.d. | F ratio | p value |
|---|---|---|---|---|---|
| basic | 85 | 78.3 | 8.58 | 8.27 | 0.005 |
| advanced | 53 | 83.2 | 11.33 | | |

Questions that discriminate significantly at $p < .10$: G, $p = .000$ and H, $p = .001$.

**Table 9**: Discrimination between job categories

| | n | mean | s.d. | F ratio | p value |
|---|---|---|---|---|---|
| miner | 63 | 78.7 | 9.3 | 2.5 | 0.062 |
| main/tech | 43 | 82.0 | 7.8 | | |
| super/mgt | 24 | 83.4 | 8.8 | | |
| other | 1 | 89.0 | 0.0 | | |

Questions that discriminate significantly at $p < .10$: H, $p = .045$ and I, $p = .095$.

## Appendix A: Problem Booklet

Duplicate this copy of the problem booklet for use in your classes. Each person in your class should have a problem booklet while they are working the exercise. The problem booklets are reusable. To save effort and money, ask the trainees to avoid marking in the booklets and collect all the booklets after the class.

You may obtain copies of the problem booklet from the University of Kentucky or the National Mine Health and Safety Academy. The addresses and telephone numbers for these two agencies are listed in the footnote on page three of this document.

# Cecil Exercise

## Problem Booklet

Behavioral Research Aspects of Safety
and Health Group (BRASH)
Institute for Mining and Minerals Research (IMMR)
University of Kentucky, Lexington, Kentucky[1]

July 1987

[1] This latent image exercise was developed and field tested under U. S. Bureau of Mines research Contract No. HO348040 with the Bureau of Mines Research Center in Pittsburgh, PA. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies or recommendations of the Interior Department's Bureau of Mines or the U. S. Government.

# Instructions

Read the problem situation described on the next page. Study the map until you understand the location of the miners and equipment in the problem. Next, answer each of the 10 questions. Do them one at a time. Don't jump ahead, but you may look back to earlier questions and answers. For most of the questions, choose only one answer unless you are told to "Try again!". A few questions ask you to select as many answers as you think are correct. Follow the instructions for each question.

After you have selected a choice to a question, look up its number on the answer sheet. Select your answer to each question by rubbing the special pen between the brackets on the answer sheet. A hidden message will appear and tell you if you are right. When you have finished, you will learn how to score your performance.

# Cecil Exercise

## Background

The mine, which is above the water table, is wet and has a 52 inch seam.

This is an 8 entry supersection, with 2 continuous miners, and 2 shuttle cars.

You (Cecil) are a continuous miner operator on the West Mains Section.

You are slim, strong, and in good shape (5' 10" and 145 lbs). Big Tim, your helper, is overweight and in poor physical condition (6' 2" and 275 lbs.).

The shuttle car roadway is littered with a large accumulation of loose coal and coal dust.

## Problem

You and Big Tim have just trammed the continuous miner to the face of the #1 entry. Your boss comes by and tells you that one shuttle car with a damaged cable is stalled between #3 and #4 in the last open crosscut, and the other is stuck near the feeder. You and Big Tim decide to replace a few worn bits while waiting. While pulling the bits, you smell something burning. Tim tells you the smell is probably just from heat shrinking the boot over the splice on the shuttle car cable. After installing the bits, you go to the mouth of the #1 entry to establish face ventilation. Your eyes begin to burn and water. You look down #1 and across to #2 and see a cloud of thick, black smoke. The smoke is going by the mouth of #1 and out the return. You immediately yell to Tim and tell him about the smoke. After studying the map on page 3, turn the page and answer the first question.

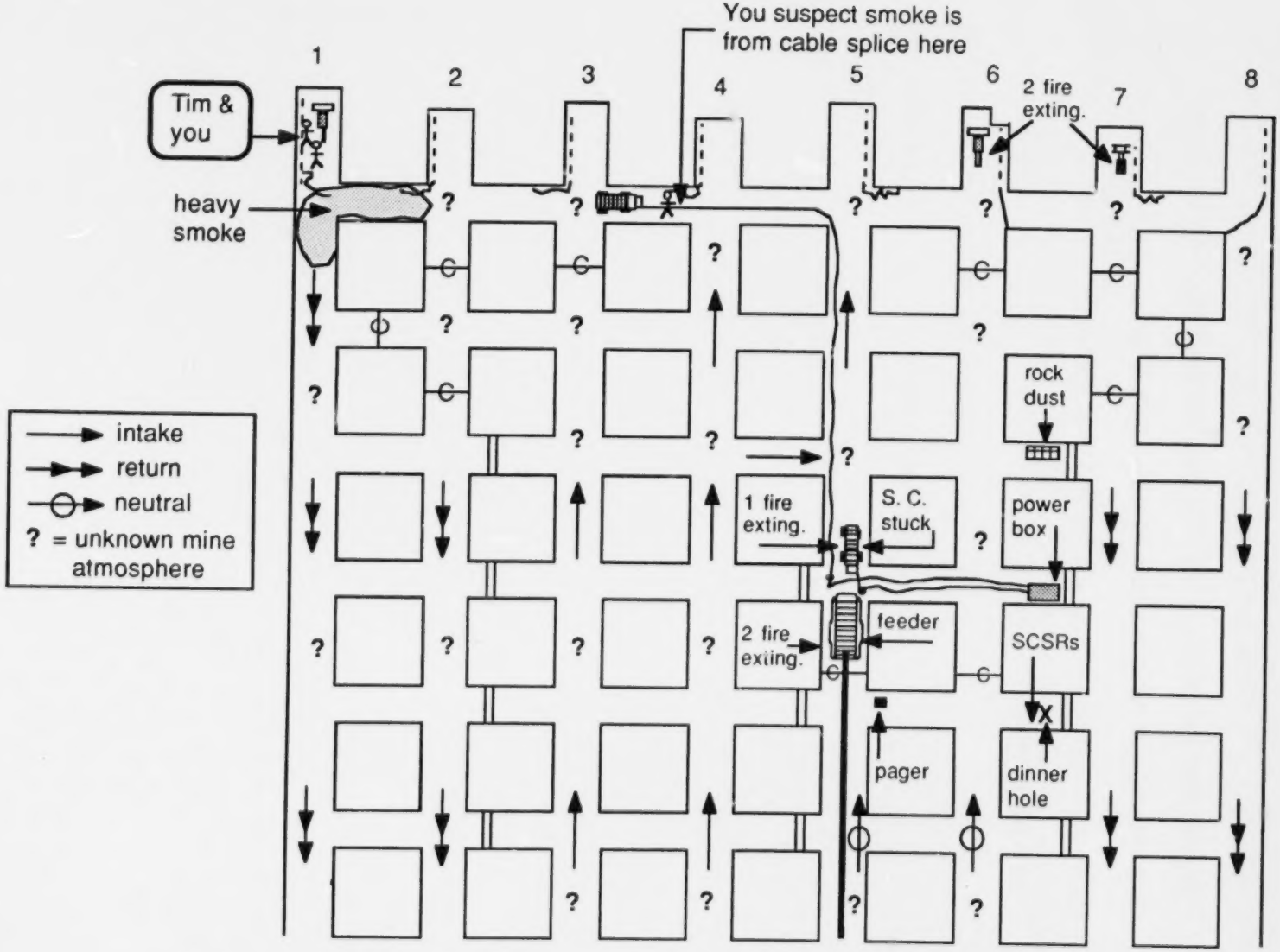



Figure 1: Your and Tim's position on the section, with the smoke cloud you can see and the possible locations of smoke marked with question marks

**Question A**

After telling Tim about the smoke, what should you do first? (Choose only ONE unless directed to "Try again!")

1. Take your filter self-rescuer off your belt and have it ready in case you need it.
2. Sit down and wait for instructions from your face boss.
3. Put on your filter self-rescuer and tell Tim to do the same.
4. Take a deep breath and head for intake air quickly.

**Question B**

As you are putting on your filter self-rescuer (FSR), Big Tim tells you that he has left his FSR on the other miner, which is broken down in the #6 entry. What would you do now? (Choose only ONE unless directed to "Try again!")

5. Finish putting on your FSR, but stop and think before taking further action.

6. Share your FSR with Tim by taking turns breathing through it, and dash through the smoke.

7. Tell Tim to stay put. Finish putting on your FSR and go across the section to get Tim's FSR.

8. Leave your FSR off and wait for help with Tim.

9. Offer your FSR to Big Tim and have him go for help.

**Question C**

Smoke is slowly drifting toward the #1 face where you and Tim were working. You must act quickly. What would be the best thing for you to do now? (Choose only ONE unless directed to "Try again!")

10. Give Tim your FSR. You're in better physical condition than he is. You can take more smoke than he can.

11. Have Tim put a damp rag over his nose and mouth. Lead him through the smoke to fresh air.

12. Leave Tim in the entry while you go through the smoke for help.

13. Drag the line curtain at the mouth of #1 to Tim. Have him hang it across the entry near the end of the miner boom and stay behind it. You go for help.

**Question D**

To limit his exposure to smoke and carbon monoxide (CO), what should Tim do as he waits for help? (Select as MANY as you think are correct.)

14. Stay as near the floor and as close to the face as is safely possible.

15. Climb on top of the miner to get above the smoke.

16. Stay next to the rib.

17. Hang a second line brattice just inby the first one.

18. Stay near the curtain(s). Lift the curtain(s) often to check for smoke.

19. Use the wash down hose to spray the curtain(s).

WHEN YOU HAVE MADE YOUR SELECTION(S) DO THE NEXT QUESTION.

**Question E**

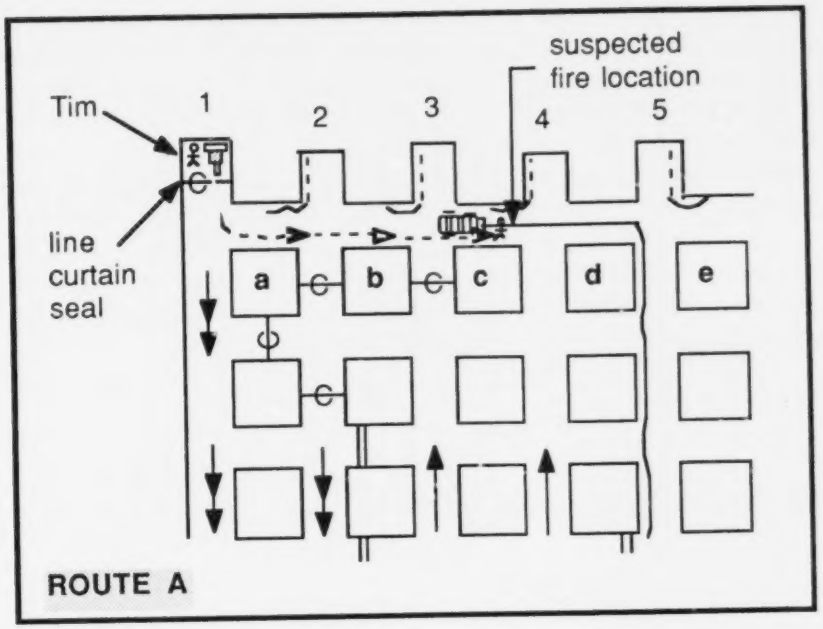
As you step into the smoke to go for help, your eyes begin to burn and water. Look at Figure 2 on the next two pages. Which path would you take? (Choose only ONE unless directed to "Try again!")

20. Route A

21. Route B

22. Route C

23. Route D



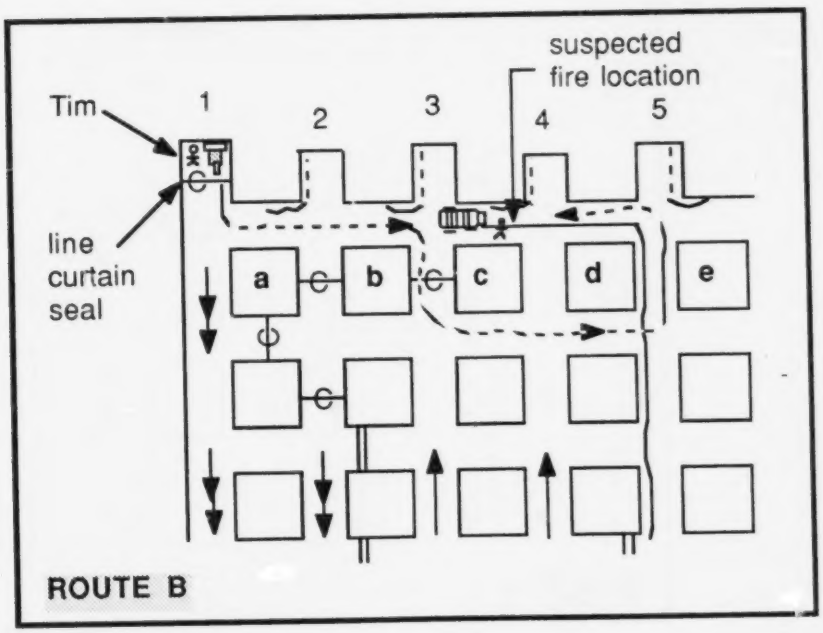
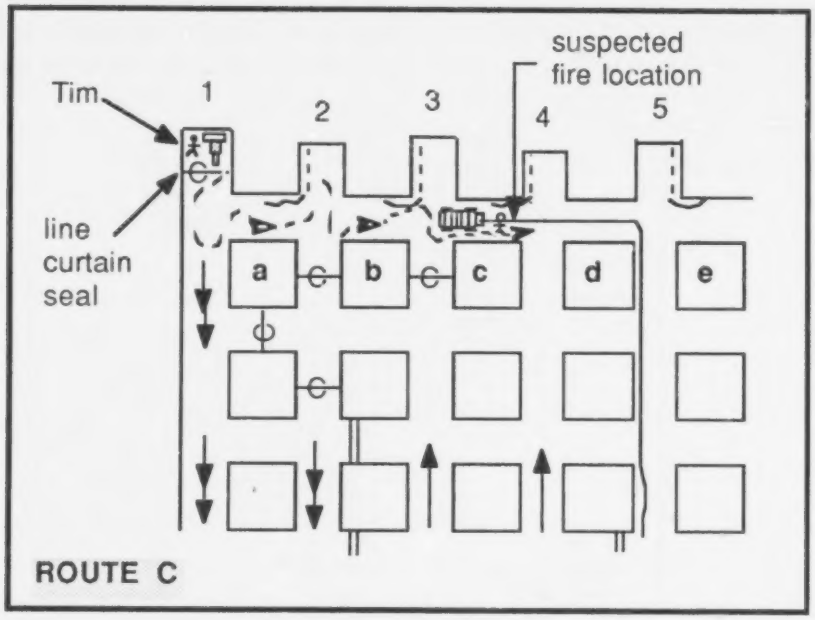




Figure 2: Four alternative routes



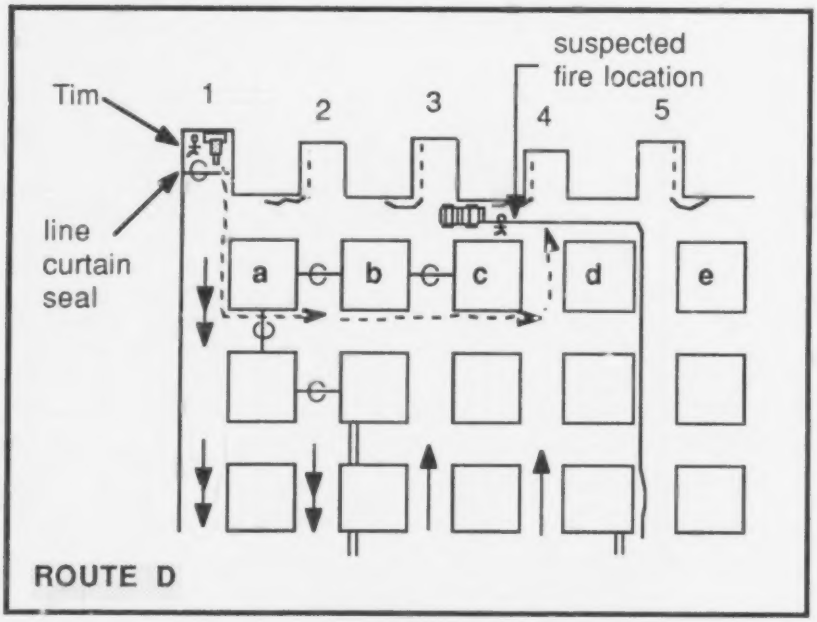




Figure 2: (continued)

**Question F**

As you look up the #4 entry (see Figure 3 on the next page) on your way for help, you see a fire. You continue along the pathway shown in Route D in Figure 2 on page 10. You see Matt Mitchell, the repairman, lying on his back on the fresh air side of the fire. His hard hat is off and is lying beside a slab of roof rock. A propane torch lies burning in a large puddle of hydraulic oil, caused by a burst roof bolter hose. The oil, cable, loose coal, and the rib are burning. The fire looks fairly small, but you can't be sure. The smoke blocks your view. You quickly examine Matt. As you do, he comes to and tells you he's OK. Matt has a large lump and small laceration on his forehead. His arm is crooked. Using a clothing drag you pull him a safe distance from the fire. At this point, what would you do? (Choose only ONE unless directed to "Try again!")

24. Fight the fire.

25. Take Matt's FSR and go back to give it to Tim so he can escape to fresh air.

26. Begin treating Matt's injuries.

27. Go toward the dinner hole for help.

28. Leave Matt and get Tim's FSR off the miner in the #6 entry.

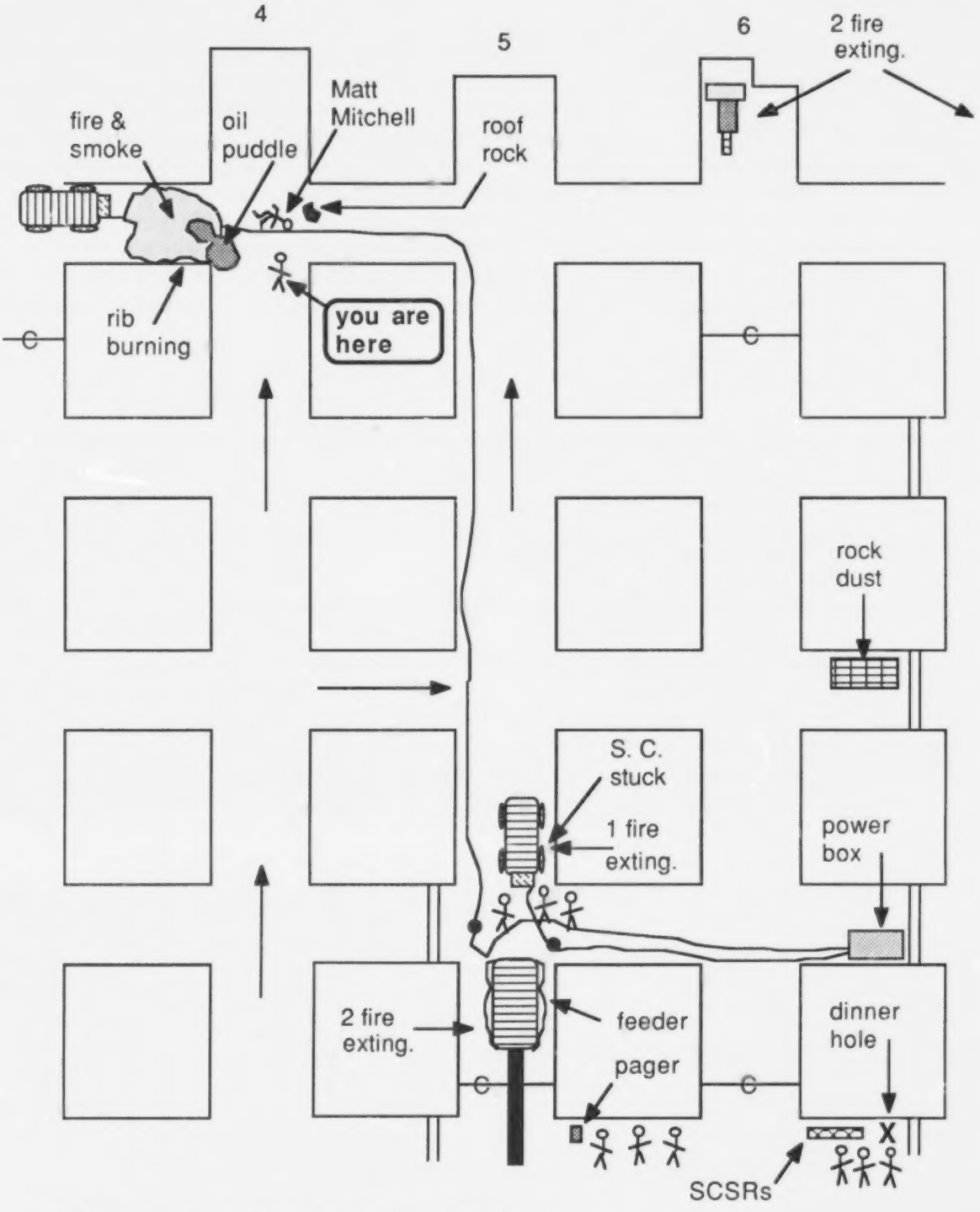



Figure 3: Location of fire, Matt, and you

**Question G**

You tell the section foreman what you've seen and done. What should he do now? (Select as MANY as you think are correct.)

29. Tell four of you to grab fire extinguishers and rock dust and go fight the fire.

30. Account for all crew members.

31. Send one miner to call outside and report the fire.

32. Tell two of you to put on SCSRs, take one with you, and go for Tim.

33. Send someone to give first-aid to Matt.

34. Send one miner to check to see that the power to the shuttle car whose cable is on fire has been knocked.

35. Send two miners to start taking apart the water line to the continuous miner in #6, and getting a hose ready to attack the fire with water from the fresh air side, in case this becomes necessary.

36. Tell two miners to short-circuit the air and direct the smoke away from the #1 face where Tim is waiting for help.

37. Send all of you to the dinner hole, to meet up with the others, and exit the mine.

38. Send one miner to get extra fire extinguishers and rock dust.

WHEN YOU HAVE MADE YOUR SELECTION(S) DO THE NEXT QUESTION.

**Question H**

You get the fire out. The air soon clears. You go over to #1 entry in fresh air. Big Tim is fine. He says his double, wet line brattices kept out the smoke. Your quick thinking and actions saved him and the mine section from harm. Big Tim says from now on he is going to carry his FSR.

Now think about the whole problem. What do you think were the major errors that contributed to this fire? (Select as MANY as you think are correct.)

39. Using a propane torch to help make a splice.

40. Matt's failure to check the top at the place he was working.

41. Failure to clean up the puddle of hydraulic oil from the roof bolter.

42. Allowing excess loose coal and coal dust to accumulate.

43. Using a flammable trailing cable.

WHEN YOU HAVE MADE YOUR SELECTION(S) DO THE NEXT QUESTION.

**Question I**

The poisonous gas in this problem was carbon monoxide (CO). Which of the following statement(s) about CO are true? (Select as MANY as you think are correct.)

44. CO displaces the oxygen normally carried by the hemoglobin of the blood.

45. CO has an acid taste in high concentrations.

46. CO is slightly heavier than air and therefore is found next to the floor.

47. CO is explosive.

48. CO is produced by combustion (e.g., by mine fires and explosions, blasting, smouldering materials, and internal combustion engines).

49. You can survive approximately 90 minutes in a concentration of 0.5% CO.

50. CO is not toxic.

51. CO is sometimes called "white damp."

52. CO will irritate eyes, nose, and throat at high concentrations.

WHEN YOU HAVE MADE YOUR SELECTION(S) DO THE NEXT QUESTION.

**Question J**

List all the violations of state and federal laws and your company rules that you can find in this problem.

**Scoring your performance**

1. Count the total number of responses you colored in that were marked "correct." Write this number in the first blank on the answer sheet.

2. Count the total number of "incorrect" responses you colored in. Subtract this number from 30. Write the difference in the second blank on the answer sheet.

3. Add the numbers on the first and second blanks. This is your score.

The best possible score of 52 results from selecting all the correct answers and no wrong answers. The worst possible score of zero results from selecting all the wrong answers and no correct answers.

## Appendix B: Answer Sheet Blanks

These are the answer sheet blanks. Copies of these blank answer sheets may be duplicated in the normal fashion. However, the answers that are found within the brackets must be printed on these blank answer sheets in latent image ink. These answers are found in Appendix C. If you have the capability to print latent image ink, make copies of the blank answer sheets. Then make a mimeograph master of the latent image answers that appear in Appendix C. Then print the invisible latent image ink on the blank answer sheets, being careful to make sure all pages print and that the appropriate answers line up with the appropriate blanks. The Master Answer Sheet in the first part of this document shows all the latent image answers in their proper place.

Most companies and trainers prefer to purchase preprinted answer sheets. You may obtain copies of preprinted latent image answer sheets from the University of Kentucky or the National Mine Health and Safety Academy. The addresses and telephone numbers for these two agencies are listed in the footnote on page three of this document. Instructions for printing your own latent image answer sheets are also available from these two agencies.

The exercise may be administered in small groups or individually. Used individually, you will need one answer sheet for each person in your class. If you use the exercise in small groups, you will need one answer sheet for each 3 to 5 persons in your class. The answer sheets are consumable. You will need a new set for each class.

Special latent image marking pens are also needed by each person who marks an answer sheet. These may be obtained from the University of Kentucky IMMR office or the National Mine Health and Safety Academy. The addresses and telephone numbers for these two agencies are listed in the footnote on page 3 of this document. You may also purchase latent image marking pens and latent image ink supplies from A. B. Dick Company, 5700 West Touhy Avenue, Chicago, Illinois, 60648, (312) 763-1900. The A. B. Dick Chicago Office can put you in touch with the local supplier in your area.

## Answer Sheet for Cecil Exercise

Use this answer sheet to mark your selections. Rub the special pen gently and smoothly between the brackets. Don't scrub the pen or the message may blur. Be sure to color in the entire message once you make a selection. Otherwise you may not get the information you need.

**Question A** (Choose only ONE unless directed to "Try again!")

1. [ ]

2. [ ]

3. [ ]

4. [ ]

**Question B** (Choose only ONE unless directed to "Try again!")

5. [ ]
   [ ]

6. [ ]
   [ ]

7. [ ]

8. [ ]
   [ ]

9. [ ]
   [ ]

**Question C** (Choose only ONE unless directed to "Try again!")

10. [ ]
    [ ]

11. [ ]
    [ ]

12. [ ]
    [ ]

**Question C** (continued)

13. [ ]
    [ ]

**Question D** (Select as MANY as you think are correct.)

14. [ ]
    [ ]

15. [ ]

16. [ ]

17. [ ]

18. [ ]

19. [ ]
    [ ]

**Question E** (Choose only ONE unless directed to "Try again!")

20. [ ]
    [ ]

21. [ ]
    [ ]
    [ ]

22. [ ]
    [ ]

23. [ ]
    [ ]
    [ ]

**Question F** (Choose only ONE unless directed to "Try again!")

24. [ ]
    [ ]

25. [ ]

26. [ ]

**Question F** (continued)

27. [ ]
    [ ]

28. [ ]
    [ ]

**Question G** (Select as MANY as you think are correct.)

29. [ ]
    [ ]

30. [ ]
    [ ]

31. [ ]
    [ ]

32. [ ]
    [ ]

33. [ ]
    [ ]

34. [ ]
    [ ]

35. [ ]
    [ ]
    [ ]

36. [ ]
    [ ]

37. [ ]
    [ ]

38. [ ]

**Question H** (Select as MANY as you think are correct.)

39. [ ]

40. [ ]
    [ ]

**Question H** (continued)

41. [ ]
[ ]

42. [ ]

43. [ ]

**Question I** (Select as MANY as you think are correct.)

44. [ ]

45. [ ]

46. [ ]
[ ]

47. [ ]

48. [ ]

49. [ ]
[ ]

50. [ ]

51. [ ]
[ ]

52. [ ]

**Question J**

END OF PROBLEM

**Finding your score**

Number of "Correct" answers you colored in = (1)_____

30 minus number of incorrect answers you colored in = (2)_____

Add blanks one and two to get your total score = (3)_____

Highest possible score = 52

Lowest possible score = 0

## TRAINEE'S QUESTIONNAIRE

1) name of exercise _____*Cecil*_____

2) your age _____ 3) your sex _____ M _____ F 4) years underground coal miner _____

5) your job title _____

Check all the areas in which you have special training, certification, and/or that you routinely perform.

| | | Special Training | Certification | Routinely Perform |
|---|---|---|---|---|
| 6) | Mine Foreman | _____ | _____ | _____ |
| 7) | Mine Safety Committee | _____ | _____ | _____ |
| 8) | Mine rescue | _____ | _____ | _____ |
| 9) | CPR | _____ | _____ | _____ |
| 10) | Advanced first aid | _____ | _____ | _____ |
| 11) | EMT | _____ | _____ | _____ |
| 12) | Advanced life support | _____ | _____ | _____ |
| 13) | Other (describe) _____ | _____ | _____ | _____ |

Think about the exercise you just finished. Circle the number which tells how much you agree or disagree with the following statements.

| | | Definitely Yes | | | Definitely No |
|---|---|---|---|---|---|
| 14) | This problem could happen in real life. | 4 | 3 | 2 | 1 |
| 15) | This exercise will help me remember something important if I am ever in a similar situation. | 4 | 3 | 2 | 1 |
| 16) | I learned something new from the exercise. | 4 | 3 | 2 | 1 |
| 17) | The exercise took too long to complete. | 4 | 3 | 2 | 1 |
| 18) | I liked working the exercise. | 4 | 3 | 2 | 1 |
| 19) | The instructor's directions were clear. | 4 | 3 | 2 | 1 |
| 20) | The written directions in the exercise were easy to understand. | 4 | 3 | 2 | 1 |
| 21) | The diagrams, charts, and pictures were easy to understand. | 4 | 3 | 2 | 1 |
| 22) | The scoring procedures were easy to understand. | 4 | 3 | 2 | 1 |
| 23) | The exercise was easy to read. | 4 | 3 | 2 | 1 |

If you have anything more to say about the exercise, please write on the back of this page. Thank you.

## Appendix C: Latent Image Answers

These pages contain the latent image answers that must be printed in the blanks of the answer sheet in Appendix B. These answers are spaced and sequenced correctly so that they exactly match up with the appropriate brackets on the answer sheet blanks.

Once the latent image ink answers have been printed on the answer sheet blanks, the special developing pen reveals the formerly invisible (latent image) printed message.

You may purchase preprinted answer sheets or you may prepare your own copies. To learn more about this option, and to determine how many answer sheets and special pens you will need, see the introductory section for Appendix B.

You shouldn't do this unless you plan to put it on now. Try again!

He's probably down at the feeder. You need to act now. Try again!

Correct! Carbon monoxide may be present. Do next question.

This is very dangerous! You and Big Tim may die. Try again!

Correct! A "snap" decision could prove fatal to both of you. You are not yet in smoke. Do next question.

This would be difficult to do, and you would likely become separated in the smoke. Try again!

There is a more critical first step. Try again!

Although "misery loves company," it is important that at least one of you is protected from carbon monoxide. Try again!

Should it be necessary for someone to get through the smoke quickly, it should be you rather than Tim. Try again!

The effects of carbon monoxide do not depend on physical condition. Try again!

This will not protect him from carbon monoxide. You still don't know the source or extent of the smoke. Try again!

Smoke is slowly drifting in toward the face. Tim would soon be overcome. Try again!

Correct! This is only a short-term solution, but should protect him until help can arrive. Do next question.

Correct! Hot air and smoke tend to rise. Moving close to the face will buy more time. He should also try to remain calm.

Hot air and smoke will be thickest near the roof.

This will not make a difference.

Correct! This will provide a second "barricade" and double protection.

Absolutely not! This would cause leakage and place Tim in danger.

Correct! The water will help seal the brattice material and provide more protection from smoke and CO.

You are in heavy, black smoke and can't see. Your FSR becomes very hot. You soon get disoriented. Try again!

You are in heavy, black smoke and can't see. Your FSR becomes very hot. You soon get disoriented. Try again!

You are in heavy, black smoke and can't see. Your FSR becomes very hot. You soon get disoriented. Try again!

Correct! By running your left hand around pillar a, you quickly get into fresh air through the check curtain in the crosscut between #1 and #2. Do next question.

The fire may soon be out of control, but there is still a more critical first step. Try again!

Matt may need his FSR. But there is a more critical first step. Try again!

There is a more critical first step. Try again!

Correct! You yell to the face boss and two other miners near the stuck shuttle car. Do next question.

It would be dangerous to go back for Tim now. There is a more critical first step. Try again!

Correct! The fire looks small. You have an adequate number of extinguishers and a good supply of rock dust.

Correct! The faceboss says that only Tim is missing. Everyone else is accounted for and now knows about the fire.

Correct! Management can help locate additional fire fighting supplies and may want to clear all miners not fighting the fire from the mine.

SCSRs are not intended for rescue. You should <u>not</u> search for Tim until the fire is extinguished and the smoke has cleared.

Correct ! Only a quick survey of his condition was done earlier. He can now be treated for his injuries at a safe distance from the fire.

Correct! This probably was done by Matt before repairs were started, but it's a good idea to check anyway.

Correct! While the others are fighting the fire with rock dust and fire extinguishers, preparations to use water should be made. The fire may be larger than first suspected.

This would be difficult to do in smoke. A mistake could interfere with keeping those fighting the fire in fresh air.

This would endanger Tim and the mine. The miners and materials needed to fight the fire are available.

Correct! These may be needed to complete the job and to put out the oil fire.

This procedure is acceptable, providing the proper precautions are taken.

Correct! Matt should have sounded the top before beginning repairs and any loose rock should have been either taken down or bolted up.

Correct! Matt should have put rock dust on the oil or pulled more cable from the reel and changed position before using the torch.

Correct! This added fuel to the fire.

All trailing cables are made from flame-retardant material.

Correct! Blood has a 300 times greater preference for CO than for oxygen.

CO is odorless, colorless, and tasteless.

CO is almost the same density as air. Generally, it rises toward the top with hot air and smoke.

Correct, but only in concentrations between 12.5 and 75%.

Correct!

Unconsciousness will occur in less than 30 minutes and death in less than an hour in only 0.16% CO.

CO is <u>extremely</u> toxic, even in very low concentrations.

Correct! But no matter what it's called, it's still very dangerous, even in very low concentrations.

Any irritation that comes from a fire is from smoke particles and not CO.